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Data Science at Scale School Speaker Series

Prof. Hans Hagen
TU Kaiserslautern

Visualization - Simulation - Scientific Computing

Challenges and Opportunities

Wednesday, October 1, 2014

9:00 - 9:30AM

TA-3, Bldg. 200, Room 116 (ACL Conference Room)

Abstract: Scientific Visualization is the transformation of digital data, derived from observation or simulation, into readily comprehensible images, and has proven to play an indispensable part of the scientific discovery process in many fields of contemporary science. Since its inception two decades ago, the techniques of Scientific Visualization have aided scientists, engineers, and others in the study of a wide variety of data including, for example, high-performance computing simulations, measured data from scanners (CT, MR, confocal microscopy, satellites), internet traffic, and financial records. One of the important themes being nurtured under the aegis of Scientific Visualization is the utilization of the broad bandwidth of the human sensory system in steering and interpreting complex processes and simulations involving voluminous data across diverse scientific disciplines. Since vision dominates our sensory input, strong efforts have been made to bring the mathematical abstraction and modeling to our eyes through the mediation of computer graphics. This interplay between various application areas and their specific problem-solving visualization techniques is a central part of the Los Alamos - Kaiserslautern cooperation.

Biography: Hans Hagen is a full professor at the Technical University of Kaiserslautern and an adjunct professor at the University of California/Davis. He is also the scientific director of the institute on Intelligent Visualization and Simulation at the German Research Center for Artificial Intelligence (DFKI). He holds a Ph.D. in mathematics from the University of Dortmund, a B. S. and M. S. in mathematics and a B. S. in computer science from the University of Freiburg. Prior to his current position, he was an associate professor at the TU Braunschweig and he had several visiting positions, especially in the USA. His research interests include all areas of scientific visualization, computer graphics and geometric modeling. He was editor in chief of the IEEE Transactions on visualization and computer graphics from 1999-2003 and is an associated editor of CAGD, Computing and Surveys on Mathematics in Industry. Prof. Hagen has published nearly 200 articles in scientific visualization, computer graphics, geometric modeling and geometry and is a member of ACM, GI, IEEE, and SIAM.

For more information contact the technical host Curt Canada, cvc@lanl.gov, 665-7453.

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Anne Berres
TU Kaiserslautern

Adaptive Particle Relaxation for Time Surfaces

Wednesday, October 1, 2014

9:30 - 10:20AM

TA-3, Bldg. 200, Room 116 (ACL Conference Room)

Abstract: In the first part of my talk, I will present a joint project with UC Davis on time surface advection.
Time surfaces are a versatile tool to visualize advection and deformation in flow fields. Due to complex flow behaviors involving stretching, shearing, and folding, straightforward mesh-based representations of these surfaces tend to develop artifacts and degenerate quickly. Common counter-measures rely on refinement and adaptive insertion of new flow particles into the surface representation. This leads to an unpredictable increase in memory requirements and has a strong impact on parallel surface extraction techniques. I will present a novel time surface extraction technique that keeps the number of required flow particles constant, while providing a high level of fidelity and enabling straightforward load balancing. The presented solution implements a 2D particle relaxation procedure that makes use of local surface metric tensors to model surface deformations. This is combined with an accurate bicubic surface representation to provide an artifact-free surface visualization. I demonstrate and evaluate benefits of the proposed method with respect to surface accuracy and computational efficiency based on a number of benchmark data sets.

In the second part of my talk, I will give an overview Fusion Reaction Visualization, a joint project with the German Aerospace Centre and Aalto University in Finland. Fusion reactors have the potential to be a safe and sustainable energy source that could last almost indefinitely. One of the major obstacles is the lack of efficiency due to turbulence in the plasma, which leads to deterioration of the fusion reaction and loss of energy output. The goal of this project is to visualize turbulence in the plasma in order to support physicists in their research on identifying causes for turbulence and on determining optimal conditions for fusion reaction. We work with simulated data of a Tokamak reactor. I will give an overview of the state and limits of the simulation output, the current state of the project within these limitations, and I will give an outlook of how we plan to overcome them to provide valuable results.

Biography: Anne Berres holds B.Sc. and M.Sc. Degrees in Computer Science from the Technical University of Kaiserslautern and is currently a Ph.D. student in Computer Science at the Technical University of Kaiserslautern. Her research interests include topology, differential manifolds, differential geometry, medical visualization, neural diseases, and probablistic tractogrphy. She was the lead author of 'Tractography in Context: Multimodal Visualization of Probabilistic Tractograms in Anatomical Context' published in the Eurographics Workshop on Visual Computing for Biology and Medicine 2012.

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Christoph Garth
TU Kaiserslautern

Scientific Visualization Research at the University of Kaiserslautern

Wednesday, October 1, 2014

10:30 - 11:15AM

TA-3, Bldg. 200, Room 116 (ACL Conference Room)

Abstract: The talk will outline research efforts towards facilitating visualization of large and complex datasets arising in the study of scientific and engineering problems, and will discuss in more detail recent research results in two areas.

First, I will describe a novel approach for applying topological analysis to multivariate scalar datasets. Adapting the concept of Pareto sets allows a characterization of joint external structures of several variables of a dataset, or alternatively the same variable across an ensemble of datasets. I will provide a brief comparison to other similar approaches, discuss computational aspects, and illustrate motivating application problems.

In the second part, I will discuss our recent efforts to achieve scalable visualization of large vector field datasets using so-called integration-based techniques, which are difficult to parallelize. Recent work has shown that work stealing as a general algorithmic approach in this context can yield very good performance and scalability.

Finally, I will conclude by discussing possible future directions and opportunities for collaboration.

Biography: Christoph Garth is an assistant professor at the Technical University of Kaiserslautern in the Computational Topology Group of the Department of Computer Science. He has published nearly 50 articles since 2004 in visualization computational topology, visual analysis, flow visualization, fluid flow and high-performance visualization.

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